

Reuse of the EON Architecture to Automate Protocol-Based Care: From AIDS to Breast Cancer

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I. The EON Architecture

For several years, our laboratory has been studying aspects of automation of protocol-based therapy. In particular, we have examined the tasks of planning treatment in a manner consistent with protocol guidelines, and of determining from online medical-record data whether patients may be eligible for particular clinical protocols. The T-HELPER system provides a computer-based medical record and decision-support features to assist in these two tasks in the domain of AIDS and HIV-related disease. T-HELPER incorporates a set of modular decision-support programs that collectively comprise the EON architecture.

Each of the modules in EON is a domain-independent "shell" that addresses a particular aspect of automating protocol-based care. These modules include: (1) reusable problem-solving methods that address tasks such as protocol therapy planning and protocol eligibility determination, (2) the RÉSUMÉ system, which automates the task of generating relevant abstractions from time-oriented, point-based data (e.g., determining that *hematocrit values* in a certain range constitute intervals of *anemia*, and (3) the Chronus system, which provides extensions to the standard relational data model to facilitate storage and retrieval of data that extend over temporal intervals.

All the knowledge of a particular clinical application area on which the EON components might operate is stored separately in a self-contained knowledge base. The knowledge base defines the broad classes of clinical interventions, laboratory tests, and medications that may be relevant in a particular area of medicine. The definitions of these classes of concepts constitutes an *ontology* of AIDS therapy. The knowledge base also specifies *instances* of the classes in the AIDS ontology (e.g., that AZT is an instance of a drug), and indicates how the instances of the concepts constitute particular protocols (e.g., how AZT is administered in a protocol for antiretroviral therapy).

Concomitant with development of EON, we have created PROTÉGÉ-II, a methodology and a suite of

tools that facilitate the construction of large knowledge bases. We have used PROTÉGÉ-II to develop the knowledge bases used by the T-HELPER system. PROTÉGÉ-II has allowed us to construct the ontology of the classes of concepts relevant in the care of patients with HIV disease (e.g., drug therapy, laboratory tests). Furthermore, we have used PROTÉGÉ-II to generate programmatically from that ontology a tool for entering the details of individual protocols. Because the tool allows users to define clinical protocols in domain-specific terms, nonprogrammers have been able to enter substantial amounts of AIDS protocol knowledge for use by T-HELPER.

II. A "T-HELPER" for Breast Cancer

Because the modules in the EON architecture are domain-independent shells, we can substitute new knowledge bases for the AIDS and HIV knowledge base that we currently use in the T-HELPER system. The problem-solving and data-management components in EON then can operate on the new knowledge bases precisely as they do in the case of T-HELPER.

We used PROTÉGÉ-II to create an ontology of concepts related to the management of breast cancer. We then caused PROTÉGÉ-II to generate a tool for entry of information related to clinical protocols in the breast-cancer domain. We entered protocol-specific information into this new tool, and then demonstrated the use of the EON architecture within the T-HELPER system to offer protocol-based decision support in the area of breast cancer. Although custom programming was required to modify elements of the T-HELPER user interface to facilitate entry of certain information important for the care of breast-cancer patients, the decision-support elements of EON were used without modification. Modeling of the breast-cancer ontology required several weeks of effort as we refined our descriptions of the concepts that are important for specification of clinical protocols in this new domain. Reuse of the components in the EON architecture, however, then allowed us to implement our prototype system for protocol-based care of breast cancer in less than one week.